VERITAS

The COVID-19 Epidemic in Rural U.S. Counties

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ARTICLE INFO	ABSTRACT
	Having first reached epidemic proportions in coastal metropolitan areas, COVID-19 has spread around the country. Reported case rates vary across counties from zero to 126 per thousand population (around a state prison in the rural county of Trousdale, Tennessee). Overall, rural counties are underrepresented relative to their share of the population, but a growing proportion of all daily cases and deaths have been reported in rural counties. This analysis uses daily reports for all counties to present the trends and distribution of COVID-19 cases and deaths in rural counties, from late March to May 21, 2020. I describe the relationship between population density and case rates in rural and non-rural counties. Then I focus on noteworthy outbreaks linked to prisons, meat and poultry plants, and nursing homes, many of which are linked to high concentrations of Hispanic, American Indian, and Black populations. The growing epidemic in rural counties is apparently driven by outbreaks concentrated in these institutional settings, which are conducive to transmission. The impact of the epidemic in rural areas may be heightened due to their weaker health infrastructure and more vulnerable populations, especially due to age, socioeconomic status, and health conditions. As a result, the epidemic may contribute to the ongoing decline of health, economic, and social conditions in rural areas. **Keywords:** COVID-19, rural health, health disparities, race/ethnicity

INTRODUCTION

After spreading around the country for at least four months (CDC, 2020), COVID-19 cases remain unevenly distributed geographically, with 193 of the 3,143 counties reporting no cases, the average county reporting 2.1 cases per thousand, and the maximum as high as 125 per thousand - in Trousdale County, Tennessee, where an outbreak at the state prison drove the epidemic (Bosman et al., 2020b). Although the U.S. epidemic has had its greatest impact in coastal urban areas, it is increasingly reaching into rural areas. In this paper I describe the spread of reported COVID-19 cases and deaths into rural counties of the United States, with attention to race/ethnic composition, population density, and institutional factors.

The COVID-19's effect on rural areas may exacerbate existing health disparities in the U.S. (Dorn et al., 2020). Although we would expect lower transmission rates in rural areas, because of lower population density, there also may be higher rates of serious complications and death because of their older age profile, poorer health status, and degraded health care infrastructure (Ameh et al., 2020; Cafer and Rosenthal, 2020). The context of urban-rural health disparity, and disparities within rural areas, are important to understand the impact of the epidemic in rural areas.

Health disparities between rural and urban areas in the U.S. are wide and growing wider (James and Cossman, 2017; Singh et al., 2017). Rural residents are older, have lower average educational attainment, and have lower incomes, than urban residents. And there are substantial disparities within the rural population, with Black, Hispanic, and American Indian populations having worse social and economic conditions than non-Hispanic Whites. Concurrently, rural ethnic minorities are more likely to report poorer health status, lack of access to medical care, and higher prevalence of chronic health problems (James et al., 2017). Rural residents also have less access to reliable health information, both from service providers and from media sources (Chen et al., 2019), and are less likely to use health information technology (Greenberg et al., 2018). These disadvantages in U.S. rural areas suggest the possibility of serious impact of the COVID-19 epidemic, despite the advantage of lower population density for transmission rates. And within rural areas, we need to assess disparate impacts by race/ethnicity and social class.

In addition, three specific institutional settings in which the epidemic has surged in the rural U.S. deserve special attention: meat and poultry processing plants, prisons, and

nursing homes and long-term care facilities. By April 28, the Centers for Disease Control and Prevention (CDC) reported results from a voluntary survey of correctional and detention facilities, which yielded responses from 37 jurisdictions. In these facilities, there were about 4,900 COVID-19 confirmed cases among prisoners, as well as 2,800 among their staffs, leading to more than 100 deaths. The outbreaks are apparently fueled by crowding, close quarters, lack of testing and medical isolation facilities, turnover among prisoners, and continuous entry and exit by staff (Wallace, 2020). Some of the biggest prison outbreaks of COVID-19 have been in rural areas, including the one in Trousdale County, Tennessee.

By April 27, 2020, CDC reported almost 5,000 cases of COVID-19 at 115 meat and poultry processing facilities in 19 states, affecting plants that employ more than one-fifth of the industry. At the extreme, one plant reported an 18 percent infection rate among its workers (Dyal, 2020). CDC suggested that the close proximity, physical exertion, fast work pace, and lack of adequate disinfecting were likely contributors to the outbreaks. Workers have reported unsafe working conditions and failure to implement steps need to reduce transmission in plants (Laughland and Holpuch, 2020). At the end of April, President Trump ordered meat processing plants to remain open (White House, 2020), even as the union representing the most workers in the industry, the United Food and Commercial Workers International Union, called for heightened safety enforcement and testing in the plants nationwide (UFCW, 2020). Many affected meat and poultry processing facilities are in rural areas, as shown in the examples below.

The CDC has not yet reported on the epidemic's impact on nursing homes, but media aggregations of state health authorities indicate more than 20,000 people have died in nursing homes nationally (Into America, 2020). Again, the rural/urban distribution of these cases is not yet known, but some nursing home outbreaks are apparent in the county case reports I provide below. In addition to these settings, early rural outbreaks apparently stemmed from tourism or seasonal housing (Carson, 2020). However, those outbreaks were overtaken by larger outbreaks in the institutional settings described here.

At this point we do not yet have the data necessary to parse the relative contribution of each of these settings to the overall COVID-19 epidemic in rural areas. However, this descriptive review of the case and death data, with an informal survey of pubic reports, indicates the potential importance of these institutional settings.

The early months of the COVID-19 epidemic have revealed a disparate impact on Black, Hispanic, and American Indian communities (Almagro and Orane-Hutchinson, 2020; Dyer, 2020; Kovich, 2020; Solis et al., 2020). In some rural cases, there is likely an overlap between race/ethnic composition and the institutional factors described here. For example, the concentration of Black prisoners in rural prisons and Hispanic workers in meat processing plants. In the absence of the data necessary to draw these connections systematically, I use race/ethnic concentration to look for patterns across counties.

In the descriptive analysis that follows, I present the trends and distribution of COVID-19 cases and deaths in rural counties, from late March to May 21, 2020, the latest data available. I describe the relationship between population density and case rates in rural and non-rural counties. Then I focus on noteworthy outbreaks linked to prisons, meat plants, and nursing homes - and associated with high concentrations of Hispanic, American Indian, and Black populations.

DATA AND MATERIALS

COVID-19 data are drawn from the database maintained by the New York Times (2020), which is updated daily with reports from public health authorities around the country. The data reported at the county level used here include the number of new confirmed (or presumed) cases and deaths each day in each county.[1] County population data, including race/ethnic composition, are 2018 estimates from the U.S. Census Bureau (2020). Rurality is drawn from the 2010 Decennial Census, from which the Census Bureau reported the percentage of each the population in each county that lived in a rural area (Ratcliffe et al., 2016). I follow the Bureau's categorization of counties as (1) completely rural (100 percent), (2) mostly rural (50-99.9 percent), and (3) mostly urban (less than 50 percent rural). In the text I refer to counties with 50 percent or more rural population as "rural." I calculate county population density as residents per square mile, using the Census Bureau's (2019) estimates of land area.[2]

Finally, for counties with large COVID-19 outbreaks, I used Internet searching, mostly relying on local or national news sources, to identify likely centers for the outbreak. Most of these are easily identified, as when the state authorities in Tennessee listed some 1300 cases over several days at the state prison in Trousdale County. I was unable to find a clearly identified source in only one prominent case: Sullivan County, NY, with about 1300 cases. In most rural counties with large outbreaks, local or national media have published news reports about the institutional settings where the outbreak began. This is much easier to identify than in urban areas, where there are many large institutions with overlapping population exposures. Nevertheless, these place notes remain informal identifiers of likely centers of the disease. Note also that the outbreaks in these counties, and the case counts I provide, are not limited to people within these institutions, as they also include people in the surrounding communities within each county.

The data for this paper is from publicly available sources. The code is written in Stata (using the maptile program for maps). The code is available here: https://osf.io/wd2n6/, including links to all data used.

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[1] The New York Times created two aggregate counties, for New York City (combining the five borough-counties) and Kansas City, Missouri (where the portions of Cass, Clay, Jackson and Platte counties in the municipality of Kansas City are combined into one). Both of these are non-rural counties, so they have little effect on this analysis.

[2] Two counties, Oglala Lakota, SD, and the Kusilvak Census Area, AK, are not included in the Census file. I retrieved their land areas from Wikipedia.

Table 1. COVID-19 cases and deaths, by county rurality: May 21, 2020

|	Counties	Cases	Deaths	Population	Cases per 1,000	Deaths per 100,000
Completely rural	704	13,559	369	5,293,130	2.6	7.0
Mostly rural	1,185	77,495	3,462	36,777,424	2.1	9.4
Mostly urban	1,255	1,480,249	90,352	285,096,928	5.2	31.7
Total	3,144	1,571,303	94,183	327,167,482	4.8	28.8
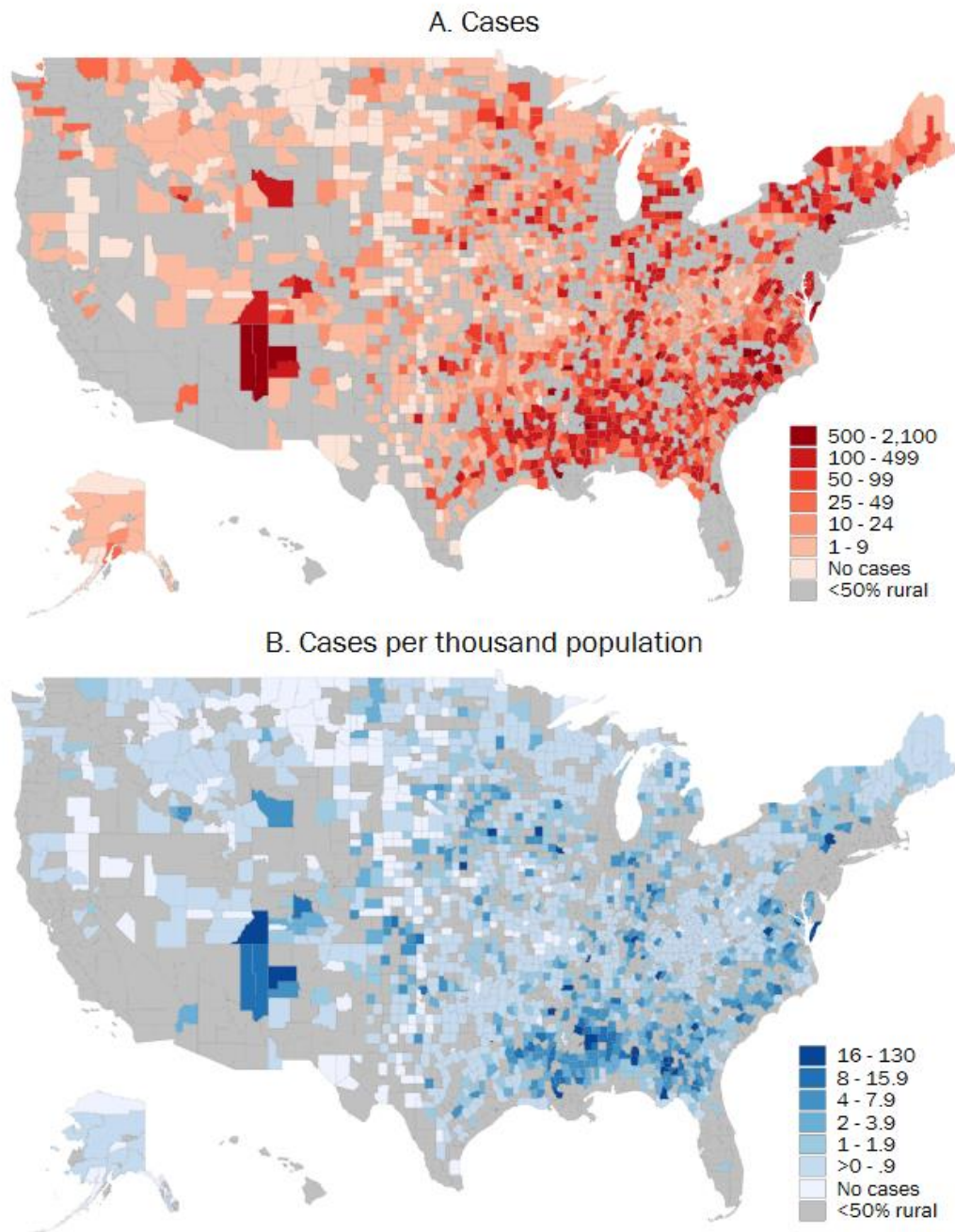
Figure 1. COVID cases in rural counties. Counties >50% rural. Data as of May 21, 2020

RESULTS

By May 21, 2020, there were 1.6 million confirmed or presumed cases of COVID-19 in the U.S., and about 94,000 deaths (**Table 1**). Case and death rates were highest in urban counties (less than 50 percent rural). Rural counties recorded about 91,000 cases and about 3,800 deaths, the great majority of them in the mostly rural category (50-99 percent rural). From **Table 1**, we can see that the rural counties (both categories combined) account for 13 percent of the population, 6.2 percent of cases and 4.3 percent of deaths.

Figure 1 uses county maps to show the distribution of rural cases across the country. Panel A shows the count of cases reported by county, which ranges from 0 to 2,044. The greatest numbers are in the Southwest (American Indian reservation
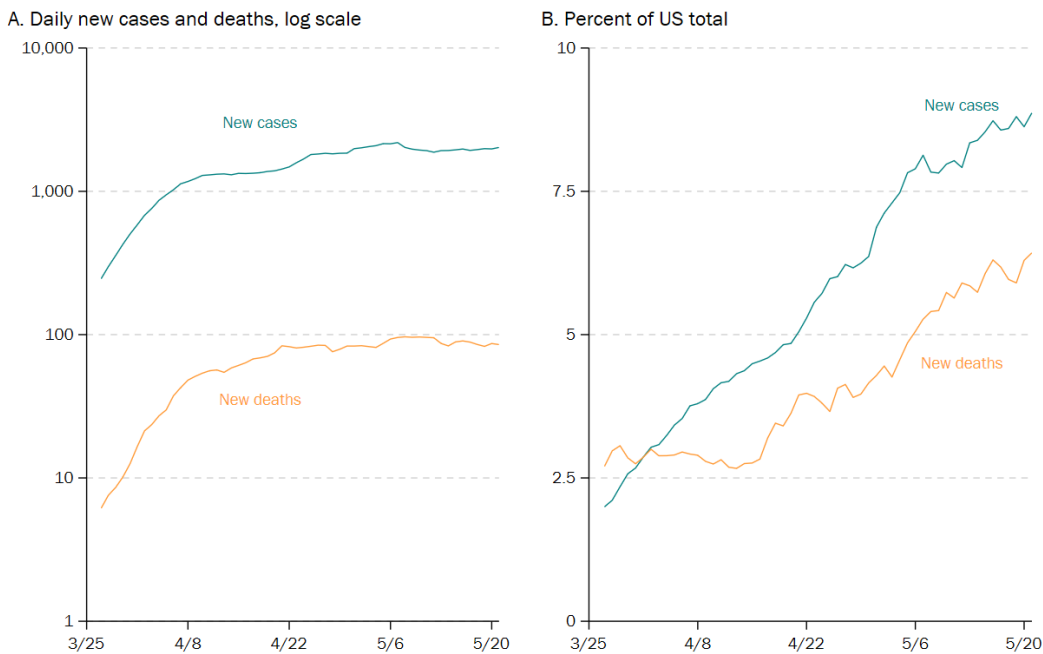
Figure 2. New COVID cases and deaths in rural counties, by date. Counties >50% rural. Seven-day trailing averages

areas), the South and Mid-Atlantic (from Louisiana to Maryland), Michigan, and New England. The upper Midwest and West have much lower numbers of rural cases. Panel B shows the same case count expressed in terms of cases per 1,000 population. This shows that the Mid-Atlantic, Michigan, and New England rural counties, although reporting many cases, do not have the highest rates per capita. The per capita map isolates counties in the Southwest, South, and Midwest that, as we will see, are sites outbreaks in prisons, meat or poultry processing plants, or nursing homes.

It is not surprising that rural counties are underrepresented in reported COVID-19 case and death rates, because community transmission of the disease was first identified in coastal urban areas where people had traveled from Europe and China (Zimmer, 2020). Not only were rural counties less likely to host the initial vectors of the disease, they also have lower population density and fewer face-to-face interactions, offering less opportunity for viral transmission. However, once establishing a foothold in some rural areas, the virus has spread robustly and their share of the epidemic has increased.

Figure 2 shows the number of new cases and deaths reported each day in rural counties, from the last week of March to mid-May, on a log scale (panel A), and the share of new cases and deaths each day that are in rural areas (panel B). Both panels present the data smoothed using seven-day trailing averages. As the epidemic slowed in much of the country in early May, including major metropolitan areas such as New York and Detroit (Bosman et al., 2020a), the pace of new reports of cases and deaths in rural areas did not slow, at more than 2,000 and just under 100 per day respectively. New cases and deaths in rural counties, as a share of the U.S. total, increased substantially over this period.

The dynamics of rural transmission are naturally different from those in urban areas, where there is more face-to-face interaction, denser housing, larger institutions, mass transportation, and larger social events. With a similar level of initial infection, transmission occurs more efficiently in areas of denser population (Rocklöv and Sjödin, 2020.). To explore differences in transmission patterns between rural and urban areas, **Figure 3** presents the relationship between COVID-19 cases per capita and population density (residents per 100 square miles), with both measures logged and including only those counties with any reported cases. The overall slope (weighted by population) is .35. However, the slope is steeper among urban (.37) than among rural (.20) counties (the slopes, and the difference between, them are highly significant statistically). Although only suggestive, this distinction might imply that rural outbreaks of the epidemic are more driven by idiosyncratic circumstances (such as the presence of a prison, meat plant, or nursing home); while transmission in urban outbreaks is generated by interactions across a wider set of social settings, determined in greater part by the level population density.

Rather than relying on overall population density to achieve viral transmission, in rural areas it appears the novel coronavirus spreads most successfully through pockets of dense and vulnerable populations within confined institutional settings. A prison in a rural area gains none of the protections of looser population concentration that benefit the wider community. **Figure 4** shows the growth of outbreaks, by county, associated with the three types of institutions described above: prisons, meat and poultry processing plants, and nursing homes. [3] (Again, the categorization of these outbreaks is drawn from my reading of local and national news

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[3] I include with nursing homes one outbreak, in East Feliciana, LA, apparently associated with a state mental hospital.

Cases per capita (log)

Figure 3. Population density and cumulative COVID cases, rural and urban counties. Rural counties are >50% rural; includes counties with any cases. Urban markers are scaled by population. Regression lines are population-weighted; with 95% confidence intervals. Data for May 21, 2020
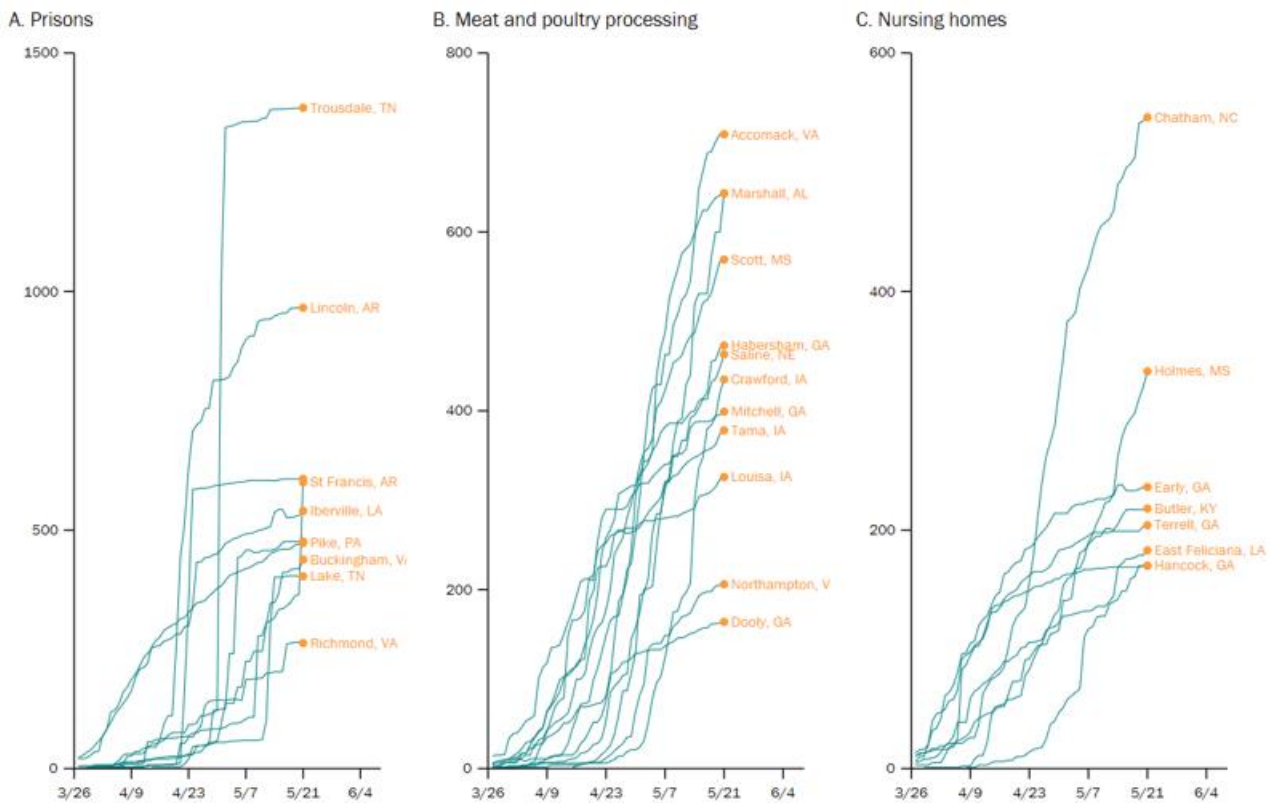
Figure 4. COVID-19 cases in selected rural counties, by date. Counties >50% rural. Data as of May 21, 2020

reports or public health authorities, and may not be definitive.) Of these, counties with prison outbreaks (panel A) report the greatest number of cases (note the y-axis scales differ across panels).[4] The prison-involved counties also demonstrate a

disturbing pattern of suddenly reporting hundreds of cases at once, which implies their testing regimes or reporting practices are not adequately capturing the true pattern of infection. Although not a comprehensive accounting of rural

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[4] Outbreaks in the counties listed are all associated with state prisons, except Pike, PA, which involves an ICE detention facility.

Table 2. COVID-19 outbreaks in selected rural counties

County	State	Population	Percent rural	Cases	Cases per 1,000	Deaths	Percent Black	Percent Hispanic	Note
Trousdale	TN	11,012	100	1,385	125.8	4	11.5	2.4	State prison
Lincoln	AR	13,383	100	966	72.2	8	30.4	3.9	State prison
Accomack	VA	32,412	100	709	21.9	11	28.6	9.3	Tyson poultry
Marshall	AL	96,109	53	643	6.7	9	3.0	14.3	Chicken
Robeson	NC	131,831	63	643	4.9	13	23.8	9.0	Poultry
Bledsoe	TN	14,755	100	607	41.1	1	7.1	2.5	State prison
St Francis	AR	25,439	52	600	23.6	0	52.9	5.4	Federal prison
Scott	MS	28,287	72	569	20.1	10	38.4	11.5	Chicken
Chatham	NC	73,139	66	546	7.5	25	12.7	12.3	Nursing home
Iberville	LA	32,721	59	540	16.5	39	48.8	2.7	State prisons
Muhlenberg	KY	30,774	68	476	15.5	7	4.9	1.5	State prison
Habersham	GA	45,388	59	473	10.4	18	4.1	15.1	Chicken
Pike	PA	55,933	71	473	8.5	18	6.5	11.4	ICE detention
Saline	NE	14,350	51	463	32.3	1	1.6	25.9	Smithfield pork
Buckingham	VA	16,999	100	438	25.8	2	33.9	2.5	State prison
Crawford	IA	17,158	52	435	25.4	2	3.9	28.5	Multiple meat
Lake	TN	7,411	100	403	54.4	0	28.7	2.4	State prison
Mitchell	GA	22,192	55	399	18.0	32	48.1	4.6	Tyson chicken
Tama	IA	16,904	72	378	22.4	23	1.0	10.3	Iowa Premium beef
Holmes	MS	17,622	87	333	18.9	21	82.5	1.1	Nursing home
Louisa	IA	11,169	100	326	29.2	6	1.1	16.2	Tysons pork
Richmond	VA	9,038	100	263	29.1	4	29.8	7.2	State prison
Early	GA	10,247	66	236	23.0	29	51.4	2.3	Nursing home
Butler	KY	12,772	100	218	17.1	6	0.6	3.5	Nursing home
Northampton	VA	11,735	100	206	17.6	16	33.9	9.3	Poultry plants
Terrell	GA	8,611	51	204	23.7	25	60.4	2.7	Nursing home
East Feliciana	LA	19,305	100	183	9.5	27	42.9	1.7	State hospital
Hancock	GA	8,348	62	170	20.4	15	71.2	2.4	Nursing home
Randolph	GA	6,833	51	170	24.9	21	61.5	2.3	Nursing home
Dooly	GA	13,706	54	164	12	12	50.0	6.9	Tyson chicken

Data as of May 21, 2020

outbreaks, the 30 counties shown in **Figure 4**, and listed in **Table 2**, together account for 15 percent of all reported rural cases, and represent the largest rural outbreaks, with the exception of those around the Navajo, Zuni, Hopi, and Fort Apache reservations, which account for an additional 4,064 cases.

Finally, I present rural COVID-19 outbreaks according to the race/ethnic composition of their counties. This makes clear that some of the outbreak counties describe above are outliers not only with regard to their number of cases, but also with regard to high minority population concentration. **Figure 5** shows rural counties and their COVID-19 case counts by population percent Hispanic (panel A), American Indian (B), and Black (C), with select counties labeled for exposition. The overall relationship between case count and percent minority is strongest for Black population (not shown), but in all three cases there are clear outlier cases comprising severe rural outbreaks in counties with disproportionate minority populations.

DISCUSSION

At this writing, rural U.S. counties account for less of the COVID-19 outbreak than their share of the population, reflecting the epidemic's initial explosion in coastal urban areas and the greater propensity for transmission in places with greater population density. However, the share of cases and deaths in rural counties is rising, apparently driven by outbreaks concentrated in institutional settings conducive to transmission: prisons, meat and poultry processing facilities, and nursing homes. In addition to the institutional factors, the impact of the epidemic in rural areas may be heightening due to their weaker health infrastructure and more vulnerable populations, especially due to age, socioeconomic status, and health conditions. As a result, the epidemic may contribute to the ongoing decline of health, economic, and social conditions in rural areas (Ajilore, 2020).

There are several notable weaknesses to this analysis. First, it relies on officially reported COVID-19 cases and deaths, which are dependent on laboratory testing and subject to underreporting (Lipsitch et al., 2020). People who administer institutions such as prisons, factories, and nursing homes are often motivated to downplay the severity of their outbreaks, even if they have the resources necessary to track them. Second, my notes on selected county cases are not a substitute for more systematic analysis. Subsequent analysis may examine the association of cases with the presence of these institutions more systematically, using databases of their locations. Finally, more systematic analysis will require consideration of all-cause mortality, which allow a more holistic assessment of the full impact of COVID-19's epidemic in rural counties (Goldstein and Lee, 2020).
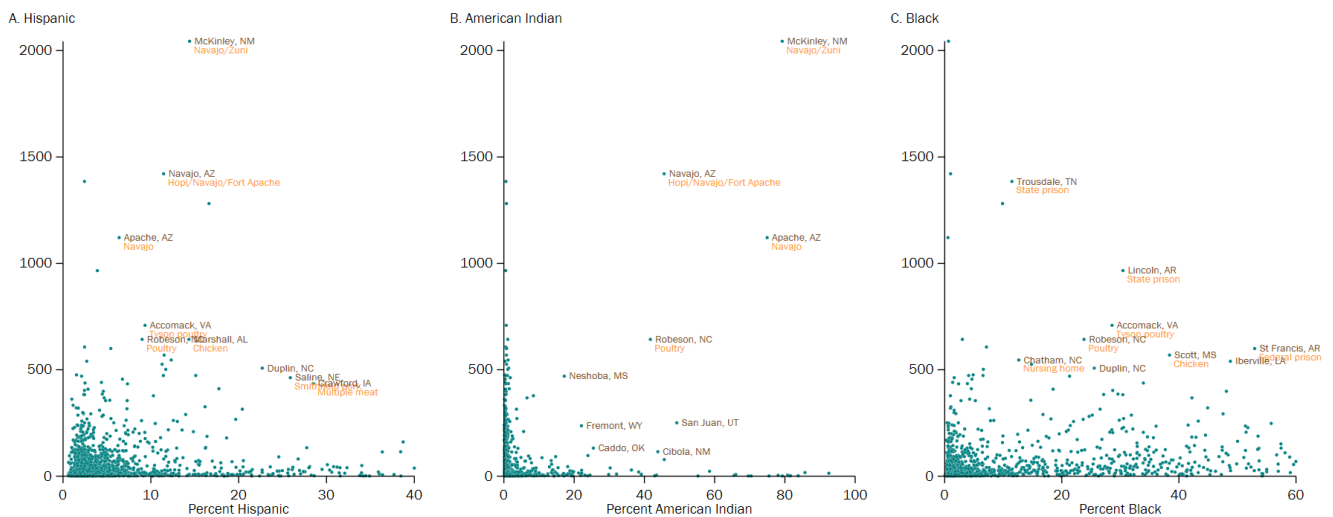
Figure 5. COVID-19 cases and minority composition in selected rural counties. Counties >50% rural. Black and American Indian are single-race counts. Counties with more than 40% Hispanic population not shown. Data as of May 21, 2020

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